

**WATER SANITIZING SYSTEM****Field of Invention**

5           This invention relates to systems for sanitizing and distributing water for use in dental and other medical procedures. In particular, this invention relates to a water sanitizing system and a distribution system for supplying sanitized water to existing delivery systems and devices for use during dental procedures.

10   **Background of the Invention**

          All dental offices routinely use water operated instruments in dental procedures, which require the water to be delivered in a controlled manner. Municipal tap water is frequently the source of this water. While municipal tap water must usually pass certain government standards so that it is generally safe to drink, tap  
15   water may contain levels of bacteria and other micro organisms which are unacceptable for use in medical procedures. These types of procedures require a source of sterile water.

          The municipal water supply may contain contaminating bacteria and other  
20   micro-organisms which can serve as a source of infection. As such, a sanitized water supply for irrigation of target areas, such as surgical wounds and for cooling of high speed dental instruments is important.

          While it is known to use sterile solution sources such as bottled water or saline  
25   solutions, many procedures, such as those utilizing micro abrasive techniques, require a large source of water for irrigation. The use of bottled fluids is impractical where large quantities of sanitized water are required.

          Moreover, even a sterile water supply can become contaminated with bacteria  
30   and other micro-organisms. For example, while sterile water can be provided to the delivery systems, this water may still become contaminated as a result of

contamination of the water supply tubing. Moreover, in a dental distributing apparatus contamination may be introduced into the water supply from an air supply used to pressurize bottled water, where micro-organisms in the air supply are exposed to the water in the distributing apparatus. Also, contamination through backwash  
5 from a patient's mouth can occur when the water supply is shut off while instruments are positioned in a patient's mouth, so that a small amount of fluid is hydraulically drawn into the water distribution system. This can quickly lead to contamination of the entire water distribution system, increasing the likelihood of infection and the spread of infection from one patient to other patients.

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This poses a particular problem in dental offices and clinics. Left unchecked, bacteria can accumulate over time within the distribution system to form a bacterial film on the inner surface of water supply lines used to distribute and dispense water in dental procedures and for cooling dental instruments. From time to time pieces of this  
15 bacterial film can break free and enter the water supply lines. These pieces of bacterial film can greatly increase the chances of infection where, for example, open wounds are being irrigated by the water supply.

Various techniques have been used to combat the problem of bacterial  
20 contamination of the distribution system, most involving flushing of the distributing system by a chemical sanitizing solution. For example, United States Patent No. 5,199,604 to Palmer and United States Patent No. 5,709,546 to Waggoner disclose the use of bactericidal solutions to irrigate and flush the water supply systems. A commercially available disinfectant such as BIO 2000 (Trademark), formerly sold  
25 under the name STERISOL (Trademark), can be used to disinfect the tubing and water channels associated with a water distributing apparatus. However, these solutions address only contamination of the distributing system, and do not address the problem of a contaminated water supply.

30 Solutions to this problem involving treatment of the water supply have been proposed, for example United States Patent No. 5,158,454 to Viebahn discloses a

method of treating the water by incorporating a strong oxidant or ozone into the water, or some type of filtration, such as United States Patent No. 5,230,624 to Wolf et al. which teaches the use of an in line filter containing a polyiodide purification resin for filtering the bacteria and micro-organisms. In any technique involving the use of an external bactericidal agent to treat the water the agents must be added to the water and thereafter removed from the system, either by a second treatment or by flushing the system with water. These steps must be repeated regularly. Moreover, available bactericidal agents are restricted to those which are not toxic to humans, and many of these can be unpleasant in terms of taste or effect in a patient's mouth. Filtration treatments usually require that a filter be changed at regular intervals as filtered micro-organisms accumulate and render the filter less effective, or eventually provide a separate source of contamination.

It would accordingly be advantageous to provide in such a water distributing apparatus a water supply sanitizing system which does not involve the use of chemical sterilizing agents or filters, and which uses ordinary tap water to provide a constant, adequate supply of sanitized water, for example for use with dental procedures that require large volumes of water. The present invention provides a batch sanitizing system which produces a convenient supply of sanitized water in batches, dispensing a sanitized batch of water while a subsequent batch of water is being sanitized.

Some dental delivery systems provide a source of disinfectant to sanitize the delivery system. In some of these systems the disinfectant source is connected to the oral cavity water delivery system at a single point from a toggle-operated selector valve, which enables the entire delivery system to be supplied with all water or all disinfectant on a mutually exclusive basis.

Other systems provide for air, water and disinfectant to be delivered via a three-passage manifold, from which the dental instruments are supplied directly and therefore by pass the complex air and water regulating and control devices built into a

dental-chair delivery system. Water and disinfectant supplies are selectable only on a mutually exclusive basis.

It would be accordingly advantageous to provide a dental delivery system having the capability of providing water and disinfectant concurrently to different parts of the delivery system on a non-exclusive basis. The present invention provides a dental dispensing apparatus capable of supplying disinfectant to certain dental delivery systems and devices while providing a supply of sanitized water to other certain dental delivery systems and devices.

The present invention thus provides a water sanitizing system, comprising a water inlet for connection to a water supply, a sanitizing region in fluid communication with the water inlet, for sanitizing water from the water supply to produce a batch of sanitized water, a reservoir for storing the batch of sanitized water, in fluid communication with the sanitizing region and having a water outlet, an upper limit level sensor and a lower limit level sensor, and a valve disposed between the sanitizing tank and the reservoir to permit a flow of water from the sanitizing region to the reservoir when the lower limit level sensor detects that a water level in the reservoir has reached a selected lower limit.

The invention further provides a method of dispensing sanitized water, comprising the steps of sanitizing a batch of water in a sanitizing region; detecting a water level in a reservoir in fluid communication with the sanitizing region; draining the batch of sanitized water from the sanitizing region to the reservoir responsive to the water level in the reservoir reaching a selected lower limit; and dispensing the sanitized water from the reservoir.

#### Brief Description of the Drawings

In drawings which illustrate by way of example only preferred embodiments of the invention,

Figure 1 is a schematic diagram of a sanitizing tank of a water sanitizing system according to the present invention;

Figure 2 is a schematic diagram illustrating the reservoir component of the sanitizing system of Figure 1;

5        Figure 3 is a schematic diagram of a dental delivery system according to the present invention;

Figure 4 is a schematic diagram of a further embodiment of the present invention; and

10        Figure 5 is a schematic diagram of the electrical circuits of the sanitizing system of Figure 4.

#### Detailed Description of the Invention

Figures 1 and 2 illustrate a preferred embodiment of the device and system of the invention. Tap water from a municipal water supply is supplied to the water sanitizing system 10 through inlet 12 in fluid communication with a sanitizing region by free discharge, to provide separation from the municipal supply system. Preferably, control of flow of the tap water into the sanitizing region is controlled by float operated valve 16.

20        In the preferred embodiment, the sanitizing region comprises a sanitizing tank 14, illustrated in Figure 1, comprising a conventional reverse-osmosis water purifying system. The tap water that is supplied to the sanitizing tank 14 is filtered through a semi-permeable membrane 15. Water is allowed to pass through the membrane 15 but the membrane 15 is impermeable to contaminants such as particulates, bacteria and pyrogens contained in tap water which are concentrated at the membrane 15. This material can later be removed or flushed from the system 10.

The sanitizing tank 14 is in fluid communication through drain valve 22 with a reservoir 20 in which the sanitized water is stored for use in dental or other medical procedures. Optionally an overflow outlets 24 are provided to divert outflow from the

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sanitizing tank 14 through valves 25 into drain 26, which allows the sanitizing tank 14 to be drained for cleaning.

As shown in Figure 2, the reservoir 20 is provided with upper and lower limit  
5 level sensors comprising high level sensor 28 and low level sensor 30 which  
respectively detect high and low water level limits for the sanitized water within the  
reservoir 20. The level sensors 28, 30 are in electrical communication with valve 22,  
preferably a solenoid valve, which controls the flow of sterilized water from the  
sanitizing tank 14 to the reservoir 20. The reservoir 20 is also preferably provided  
10 with a removable airtight lid 29 to facilitate thorough cleaning and disinfecting of the  
reservoir 20, and a drain 21 which allows the reservoir 20 to be emptied through valve  
23 into drain 21 for cleaning.

Preferably water drains from the sanitizing tank 14 to the reservoir 20 by  
15 gravity feed, and the sanitizing tank 14 is accordingly positioned at a level higher than  
the reservoir 20, to supply a head pressure for refilling the reservoir 20. Sanitized  
water is preferably dispensed from the reservoir 20, for example into a dental  
dispensing apparatus such as that shown in Figure 3, under pressure from a  
pressurized air source in communication with the reservoir 20 through inlet 34.

20 The pressurized air source may be the same air source used to distribute and  
dispense air in the dental office, or a separate air source may be provided. Preferably  
the solenoid valve 36 is a three-way solenoid valve with an air relief port, which  
allows for air to be released from the reservoir 20 as it fills with sanitized water from  
the sanitizing tank 14. Also, when the low level sensor 30 detects a low level  
25 condition in the reservoir 20 conventional control circuitry (not shown) closes the air  
valve 36 to relieve any residual pressure in the reservoir 20 through the air relief port  
of the valve 36 before the valve 22 is opened, to prevent backflow from the reservoir  
20 to the sanitizing tank 14. When the high level sensor 28 detects a high level  
30 condition the control circuitry closes solenoid valve 22 to shut off the supply from

sanitizing tank 14 and opens the solenoid valve 36 to introduce pressurized air to the reservoir 20 for further dispensing.

5 In the preferred embodiment, the batch of water stored between the upper and lower level limits of the reservoir 20 may be approximately one gallon, which is suitable for most dental procedures. For special procedures requiring more water, or for use in industrial processes or other medical uses in which a higher rate of sanitized water supply may be required, the capacity of the sanitizing tank 14 and/or the reservoir 20 can be adapted accordingly. In any case the sanitization process  
10 according to the invention operates as a batch procedure, wherein a predetermined volume of water is being sanitized in the sanitizing tank 14 while a previously sanitized batch of water is available for dispensing from the reservoir 20 in the manner indicated above.

15 An embodiment of a dental dispensing apparatus 2 utilizing an air/water distribution system commonly found in dental chairs is shown in Figure 3 by way of example. However, the sanitizing system of the invention is capable of more general application and is not limited to use with any particular dispensing apparatus or distribution system. Conversely, the dispensing apparatus of the invention is not  
20 limited to use with the batch sanitizing system of the invention, although it may be advantageously so employed.

The dispensing apparatus 2 is capable of interfacing with existing air and water regulating and control devices in a dental office, providing decontamination and  
25 flushing facilities and selecting particular devices, such as high-speed drills, to be supplied with either water or disinfectant while maintaining "water only" supplies to other instruments such as syringes. Thus, unlike conventional dispensing systems the provision of sanitized water or disinfectant in the dispensing system of the invention is on a non-exclusive basis.

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Sanitized water is fed to the water distributing or dispensing apparatus 2 shown in Figure 3 on demand through reservoir outlet 38, controlled by solenoid valve 42. Sanitized water from the batch sanitizing system shown in Figures 1 and 2 is supplied to an existing utility module 41 at inlet port 47 in the dental dispensing apparatus 2 through main shut-off valve 42.

Sanitized air from an external compressed air system (not shown) is provided through main shut-off valve 43 of the dispensing apparatus 2. The air travels through suitable tubing to the inlet port of the point of a conventional point-of-use air filter 45 (typically integrated into the dental chair) where the air is filtered. Filtered air egresses from the outlet port of the filter 45 and flows to the inlet port 60 of the air manifold 46. The filtered air is supplied to inlet port 44 of the utility module 41 through outlet port 61 of the manifold 46 to provide the necessary pressure to supply the air delivery requirements of the dental dispensing apparatus 2. Air is supplied directly from the compressor to the reservoir 20 through inlet 34.

The pressurized sanitized water is supplied through outlet port 48 of utility module 41 which is in fluid communication with one of the inlet ports of selector valve 49. The outlet port of valve 49 is connected to inlet port 72 of water manifold 50. Outlet port 73 of the water manifold 50 is in turn in fluid communication with oral cavity water inlet port 52 of control block 53. Similarly outlet port 75 of water manifold 50 is in fluid communication with syringe block 8. Existing tubing for supplying air from the utility module 41 to the various dental devices such as drills 4 and syringes 6 remains unchanged, allowing the distribution system 2 of the invention to be readily incorporated into existing dental office equipment.

The disinfectant bottle assembly 62 is supplied with air from outlet port 67 of air manifold 46 via an air-pressure regulator 63 and shut-off valve 64. When air pressure is applied to the bottle assembly 62, the disinfectant solution is driven up a dip-tube to one inlet port of selector valve 65; the outlet port of valve 65 is connected to inlet port 80 of disinfectant manifold 66.

Water and disinfectant supplies to additional devices such as a cavitron device may be provided from ports 76 and 86 of the manifolds, respectively, if required.

5           The outlet port 70 of water manifold 50 is connected to the second inlet port of selector valve 65, and outlet port 83 of disinfectant manifold 66 is connected to the second inlet port of selector valve 49.

10           Outlet port 73 of water manifold 50 is connected to one inlet port of selector valve 54. Inlet port 52 of control block 53 is connected to the outlet port of selector valve 54. Outlet port 84 of disinfectant manifold 66 is connected to the other inlet port of selector valve 54.

15           Water outlet port 55 of control block 53 is connected to one inlet port of selector valve 56. Outlet port 74 of water manifold 50 is connected to the other inlet port of selector valve 56. The outlet port of selector valve 56 is connected to a syringe 6.

20           The operation of the preferred embodiment of the invention will be described in the context of the dental delivery system of Figure 3. When main air valve 43 is open, air is supplied to utility module 41 via air filter 45 through air manifold 46 and communicated to inlet port 44 of the utility module 41. Air is also supplied to disinfectant bottle assembly 62 via air manifold 46, regulator 63 and control valve 64. The existing air delivery system from the utility module to various devices (not  
25           shown) is conventional and well known to those skilled in the art.

          When main water valve 42 is open, sanitized water is supplied from the reservoir 20 to utility module 41 at inlet port 47 and regulated sanitized water for use in, for example, the oral cavity, exits at port 48 and flows to selector valve 49.

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When valve 49 is in the "WATER SUPPLY" position A, the water manifold 50 is charged with water which can then be delivered to various devices. For example, when valve 49 is in the "WATER SUPPLY" position A and valve 54 is in the "WATER SUPPLY" position C, the high speed drill 4 receives water through the master block 51; similarly, when valve 56 is in the "WATER SUPPLY" position E, syringe 6 receives water through port 55 of the control block 53. Assistant's syringe block 8 has an uninterrupted water supply directly from port 75 of manifold 50.

As the batch of sanitized water is depleted and the water level in the reservoir 20 reaches the low level sensor 30, conventional control circuitry closes main shut-off valve 42, closes the air valve 36 to relieve any residual pressure in the reservoir 20 through the air relief port of the valve 36, and opens valve 22 to drain another batch of sanitized water into the reservoir 20. When the high level sensor 28 detects a high level condition the solenoid valve 22 is closed to interrupt communication between the reservoir 20 and the sanitizing tank 14, the main shutoff valve 42 is opened to restore the supply of sanitized water to the dispensing apparatus 2, and the solenoid valve 36 is opened to reintroduce pressurized air to the reservoir 20.

Air is supplied to disinfectant bottle assembly 62 through pressure regulator 63. When valve 65 is in the "DISINFECTANT" position G, the disinfectant manifold 66 is charged to deliver the disinfectant solution as required. For example, with valve 65 in this position and with valve 54 in the "DISINFECTANT" position D, disinfectant is supplied to the high speed drill 4 through master block 51. In this manner, the high speed drill 4 can be flushed with the disinfectant solution while at the same time, syringe 6 can be supplied with water from port 74 of water manifold 50 when valve 56 is in the "WATER SUPPLY" position F.

In order to purge the system with disinfectant solution, selector valve 49 is set to the "DISINFECT FLUSH" position B. This shuts off the water supply from the utility module 41. Valve 65 is set to the "DISINFECTANT" position G. Disinfectant solution in manifold 66 charges water manifold 50 through valve 49. This expels

disinfectant fluid through all tubing and devices connected to the water manifold 50. In this operation, valve 54 is set to the "WATER SUPPLY" position C and valve 56 is set to the "BLOCK SUPPLY" position E. Syringe block 8 is also flushed with disinfectant during this procedure. Valve 56 is toggled to the "DIRECT SUPPLY" position F to expel water from the tubing connected from port 74 in the water manifold 50.

All tubing is then charged with disinfectant solution which is preferably left to stand over night. To flush the system of the disinfectant solution, valve 65 is set to the "WATER SUPPLY" position H and valve 49 to the "WATER SUPPLY" position A. Valve 54 is set to the "WATER SUPPLY" position C. Valve 56 is set to the "BLOCK SUPPLY" position E. Toggling valve 56 to the "DIRECT SUPPLY" position F purges the disinfectant from port 74 and the tubing to valve 56. Toggling valve 54 to the "DISINFECTANT" position D purges the disinfectant from the disinfectant manifold 66 and the tubing that connects outlet port 84 to valve 54.

In a further preferred embodiment, illustrated in Figures 4 and 5, the sanitizing tank 114 comprises a pasteurizing system comprising a conventional heating element 116, which heats the water to a predetermined temperature, preferably at least 82 degrees C (180 degrees F) as measured by a temperature sensor 117, in order to sterilize the water. The sanitizing tank 114 is hermetically sealed, and a check valve 118 is preferably provided upstream of the sanitizing tank 114 to prevent backflow into the municipal water supply. In this embodiment also the sanitizing tank 114 preferably has a removable lid (not shown) which can be removed to permit thorough disinfecting and cleaning.

In the operation of this embodiment, the heating coil 116 is preferably activated a preset time, for example 30 minutes, after the sterilizing tank 114 is filled. The temperature sensor 117 detects the temperature of the water within the sterilizing tank 114 and communicates a signal to close switch TS1 and activate the heating coil 116, to heat the water in the sterilizing tank 114 to the desired sterilizing temperature

(eg. 180 degrees F). Once the preset sterilizing temperature has been reached, and preferably maintained for thirty minutes, switch TS1 is opened and the sterilized water is permitted to cool for use. When the sterilized water has cooled to the desired use temperature (eg. 68 degrees F), switch TS2 closes to open solenoid valve 132 and, 5 so long as high level sensor 128 is not indicating that the reservoir 120 is filled to the upper limit, allow the sterilized water to drain from the sterilizing tank 114 into the reservoir 120.

When the lower limit of the water level in the reservoir 120 is detected by the 10 lower limit sensor 130, solenoid valve 140 is closed to shut off the water supply to the dispensing apparatus (not shown). If the temperature sensor 117 indicates that sterilized water in the sterilizing tank 114 has cooled to the preset use temperature, solenoid valve 132 is opened to allow the sterilized water to drain from the sterilizing tank 114 into the reservoir 120. When the high level sensor 128 is activated, the valve 15 132 closes and flow from the sterilizing tank 114 to the reservoir 120 is cut off. Thus, the batch of water in the reservoir 120 is always sterile and at the desired use temperature. It is preferred that sanitizing tank 114 is sized to sanitize or pasteurize only one batch of water per day. The system should be drained and cleaned at the end of each day.

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While the water sanitizing system of the invention is advantageously utilized in conjunction with the water dispensing system 2 of the invention or another water distributing or dispensing apparatus for dental procedures, it will be appreciated by those skilled in the art that the utilization of this system is not limited to dental 25 applications. The invention may also be utilized in industrial, research and medical facilities where clean water is required in large quantities. Based on the design of this sanitizing system, capacities for widely varying amounts of required water may be readily accommodated.

30 Preferred embodiments of the invention having been described herein by way of example, other modifications and adaptations will be apparent to those skilled in

the art. The invention includes all such modifications or variations as fall within the scope of the appended claims.